

UNIT TERMINAL OBJECTIVE

- 4-5 At the completion of this unit, the paramedic student will be able to integrate pathophysiological principles and the assessment findings to formulate a field impression and implement a treatment plan for the trauma patient with a suspected head injury.

COGNITIVE OBJECTIVES

At the completion of this unit, the paramedic student will be able to:

- 4-5.1 Describe the incidence, morbidity, and mortality of facial injuries. (C-1)
- 4-5.2 Explain facial anatomy and relate physiology to facial injuries. (C-1)
- 4-5.3 Predict facial injuries based on mechanism of injury. (C-1)
- 4-5.4 Predict other injuries commonly associated with facial injuries based on mechanism of injury. (C-2)
- 4-5.5 Differentiate between the following types of facial injuries, highlighting the defining characteristics of each: (C-3)
 - a. Eye
 - 2. Ear
 - 3. Nose
 - 4. Throat
 - 5. Mouth
- 4-5.6 Integrate pathophysiological principles to the assessment of a patient with a facial injury. (C-3)
- 4-5.7 Differentiate between facial injuries based on the assessment and history. (C-3)
- 4-5.8 Formulate a field impression for a patient with a facial injury based on the assessment findings. (C-3)
- 4-5.9 Develop a patient management plan for a patient with a facial injury based on the field impression. (C-3)
- 4-5.10 Explain the pathophysiology of eye injuries. (C-1)
- 4-5.11 Relate assessment findings associated with eye injuries to pathophysiology. (C-3)
- 4-5.12 Integrate pathophysiological principles to the assessment of a patient with an eye injury. (C-3)
- 4-5.13 Formulate a field impression for a patient with an eye injury based on the assessment findings. (C-3)
- 4-5.14 Develop a patient management plan for a patient with an eye injury based on the field impression. (C-3)
- 4-5.15 Explain the pathophysiology of ear injuries. (C-1)
- 4-5.16 Relate assessment findings associated with ear injuries to pathophysiology. (C-3)
- 4-5.17 Integrate pathophysiological principles to the assessment of a patient with an ear injury. (C-3)
- 4-5.18 Formulate a field impression for a patient with an ear injury based on the assessment findings. (C-3)
- 4-5.19 Develop a patient management plan for a patient with an ear injury based on the field impression. (C-3)
- 4-5.20 Explain the pathophysiology of nose injuries. (C-1)

- 4-5.21 Relate assessment findings associated with nose injuries to pathophysiology. (C-3)
- 4-5.22 Integrate pathophysiological principles to the assessment of a patient with a nose injury. (C-3)
- 4-5.23 Formulate a field impression for a patient with a nose injury based on the assessment findings. (C-3)
- 4-5.24 Develop a patient management plan for a patient with a nose injury based on the field impression. (C-3)
- 4-5.25 Explain the pathophysiology of throat injuries. (C-1)
- 4-5.26 Relate assessment findings associated with throat injuries to pathophysiology. (C-3)
- 4-5.27 Integrate pathophysiological principles to the assessment of a patient with a throat injury. (C-3)
- 4-5.28 Formulate a field impression for a patient with a throat injury based on the assessment findings. (C-3)
- 4-5.29 Develop a patient management plan for a patient with a throat injury based on the field impression. (C-3)
- 4-5.30 Explain the pathophysiology of mouth injuries. (C-1)
- 4-5.31 Relate assessment findings associated with mouth injuries to pathophysiology. (C-3)
- 4-5.32 Integrate pathophysiological principles to the assessment of a patient with a mouth injury. (C-3)
- 4-5.33 Formulate a field impression for a patient with a mouth injury based on the assessment findings. (C-3)
- 4-5.34 Develop a patient management plan for a patient with a mouth injury based on the field impression. (C-3)
- 4-5.35 Describe the incidence, morbidity, and mortality of head injures. (C-1)
- 4-5.36 Explain anatomy and relate physiology of the CNS to head injuries. (C-1)
- 4-5.37 Predict head injuries based on mechanism of injury. (C-2)
- 4-5.38 Distinguish between head injury and brain injury. (C-3)
- 4-5.39 Explain the pathophysiology of head/ brain injuries. (C-1)
- 4-5.40 Explain the concept of increasing intracranial pressure (ICP). (C-1)
- 4-5.41 Explain the effect of increased and decreased carbon dioxide on ICP. (C-1)
- 4-5.42 Define and explain the process involved with each of the levels of increasing ICP. (C-1)
- 4-5.43 Relate assessment findings associated with head/ brain injuries to the pathophysiologic process. (C-3)
- 4-5.44 Classify head injuries (mild, moderate, severe) according to assessment findings. (C-2)
- 4-5.45 Identify the need for rapid intervention and transport of

- the patient with a head/ brain injury. (C-1)
- 4-5.46 Describe and explain the general management of the head/ brain injury patient, including pharmacological and non-pharmacological treatment. (C-1)
- 4-5.47 Analyze the relationship between carbon dioxide concentration in the blood and management of the airway in the head/ brain injured patient. (C-3)
- 4-5.48 Explain the pathophysiology of diffuse axonal injury. (C-1)
- 4-5.49 Relate assessment findings associated with concussion, moderate and severe diffuse axonal injury to pathophysiology. (C-3)
- 4-5.50 Develop a management plan for a patient with a moderate and severe diffuse axonal injury. (C-3)
- 4-5.51 Explain the pathophysiology of skull fracture. (C-1)
- 4-5.52 Relate assessment findings associated with skull fracture to pathophysiology. (C-3)
- 4-5.53 Develop a management plan for a patient with a skull fracture. (C-3)
- 4-5.54 Explain the pathophysiology of cerebral contusion. (C-1)
- 4-5.55 Relate assessment findings associated with cerebral contusion to pathophysiology. (C-3)
- 4-5.56 Develop a management plan for a patient with a cerebral contusion. (C-3)
- 4-5.57 Explain the pathophysiology of intracranial hemorrhage, including: (C-1)
- a. Epidural
 2. Subdural
 3. Intracerebral
 4. Subarachnoid
- 4-5.58 Relate assessment findings associated with intracranial hemorrhage to pathophysiology, including: (C-3)
- a. Epidural
 - b. Subdural
 3. Intracerebral
 4. Subarachnoid
- 4-5.59 Develop a management plan for a patient with a intracranial hemorrhage, including: (C-1)
- a. Epidural
 2. Subdural
 3. Intracerebral
 4. Subarachnoid
- 4-5.60 Describe the various types of helmets and their purposes. (C-1)
- 4-5.61 Relate priorities of care to factors determining the need

- for helmet removal in various field situations including sports related incidents. (C-3)
- 4-5.62 Develop a management plan for the removal of a helmet for a head injured patient. (C-3)
- 4-5.63 Integrate the pathophysiological principles to the assessment of a patient with head/ brain injury. (C-3)
- 4-5.64 Differentiate between the types of head/ brain injuries based on the assessment and history. (C-3)
- 4-5.65 Formulate a field impression for a patient with a head/ brain injury based on the assessment findings. (C-3)
- 4-5.66 Develop a patient management plan for a patient with a head/ brain injury based on the field impression. (C-3)

AFFECTIVE OBJECTIVES

None identified for this unit.

PSYCHOMOTOR OBJECTIVES

None identified for this unit.

DECLARATIVE

- I. Facial Injury
 - A. Introduction
 - 1. Incidence
 - 2. Morbidity and mortality
 - 3. Risk
 - B. Review of anatomy/ physiology of the face
 - 1. Arteries and nerves
 - 2. External carotid
 - a. Temporal artery
 - b. Mandibular artery
 - c. Maxillary artery
 - 3. Nerves
 - a. 5th cranial nerve - trigeminal
 - b. 7th cranial nerve - facial
 - 4. Bones
 - a. Nasal
 - b. Zygoma/ zygomatic arch
 - c. Maxilla
 - d. Mandible
 - C. Common mechanisms of injury
 - 1. Blunt
 - a. Motor vehicular crashes
 - b. Falls
 - c. Body-to-body contact
 - d. Augmented force (i.e. sticks, clubs, etc.)
 - 2. Penetrating
 - a. Gun shot wound, stabbing
 - b. Bites - dog, human, biting tongue
 - D. Other common associated injuries
 - 1. Airway compromise
 - 2. Cervical spine injury
 - 3. Brain injury
 - 4. Dental trauma or avulsion
 - E. Types of facial injuries
 - 1. Bony injury
 - a. Mandible
 - (1) Fracture
 - (2) Dislocation
 - b. Maxillary fracture
 - (1) LeFort I, II and III
 - c. Zygomatic fracture
 - d. Orbital fracture

- (1) Eye
 - (2) Ear
 - (3) Nose
 - (4) Throat
 - (5) Mouth
 - e. Nasal fracture
 - 2. Soft tissue
 - a. Face
 - b. Mouth and oropharynx and tongue
 - c. Ear
 - d. Eye
- F. Assessment
- 1. Airway patency and adequate ventilation
 - 2. Cervical spine integrity
 - 3. Adequate perfusion
 - 4. Associated injury
 - a. Head injury
 - (1) Increased ICP
 - (2) Presence of CSF
 - b. Bony injury
 - (1) Malocclusion
 - (2) Depressed zygoma
 - (3) Facial asymmetry
 - (4) Diplopia/ blurred vision
 - c. Soft tissue injury
 - (1) Open wounds
 - (2) Hematomas
 - d. Broken or missing teeth
- G. History
- 1. Mechanism of injury
 - 2. Events leading up to the injury
 - 3. Time it occurred
 - 4. Associated medical problems
 - 5. Allergies
 - 6. Medications
 - 7. Last intake
- H. Management
- 1. Airway patency and adequate ventilations a priority
 - a. Suctioning
 - b. Intubating
 - c. Positioning
 - d. Ventilating
 - 2. Assuring adequate circulation
 - 3. Assuring cervical spine integrity

- II. Throat injuries
 - A. Introduction
 - 1. Incidence
 - 2. Morbidity and mortality
 - 3. Risk
 - B. Review of anatomy/ physiology of the throat
 - 1. Critical structures
 - a. Airway
 - (1) Oropharynx
 - (2) Larynx
 - (3) Trachea
 - b. Cervical spine
 - (1) Cord
 - (2) Vertebra
 - c. Major vessels
 - (1) Internal and external jugular veins
 - (2) Carotid arteries
 - (3) Vertebral arteries
 - 2. Associated structures
 - a. Vagus nerves
 - b. Thoracic duct
 - c. Pharynx and esophagus
 - d. Thyroid gland and parathyroid glands
 - e. Lower cranial nerves
 - f. Brachial plexus - responsible for lower arm and hand function
 - g. Muscles - platysma is major muscle
 - h. Soft tissue and fascia
 - C. Mechanism of injury
 - 1. Blunt - motor vehicle crashes, blow to the neck, hanging
 - 2. Penetrating - gun shot wound, stabbing, arrow
 - a. Lacerations or puncture
 - D. Pathophysiology
 - 1. Transected trachea
 - a. Larynx separated from trachea or fractured
 - (1) Vocal cord swelling or contusion
 - (2) Disruption of normal airway landmarks
 - (3) Associated soft tissue swelling
 - b. Open wound to trachea
 - 2. Vessel lacerated or torn
 - a. Arterial interruption
 - (1) Hypoxia to brain tissue and infarct

- (2) Open wound may cause an air embolism
 - b. Rapid exsanguination
 - 3. Cervical spine trauma
 - a. Vertebral instability
 - b. Cord interruption
 - (1) Paralysis or paresthesia
 - (2) Neurogenic shock
 - 4. Impaled object
 - a. Do not remove unless obstructing airway
 - b. Consider emergency cricothyrotomy
- E. Assessment
- 1. Signs - pale or cyanotic face, bruising of neck, redness of area, hematoma in neck, with open wound will see frothy blood or sputum in wound; subcutaneous air may be present
 - 2. Symptoms - voice changes, tickle or feeling of fullness in throat, pain on palpation
 - 3. Signs of stroke with air emboli or infarct
 - 4. Signs of paralysis, paresthesia or neurogenic shock if spinal cord involved
 - 5. Assess for other injury
- F. Management
- 1. Airway patency and adequate ventilation a priority
 - a. If open wound to trachea
 - (1) ET tube can be inserted to maintain patency
 - b. If closed wound
 - (1) BVM with oxygen supplement
 - (2) Consider intubation - soft tissue swelling may be extreme, aim for bubbles
 - (3) Consider emergency cricothyrotomy
 - 2. Maintenance of adequate tissue perfusion
 - a. If open wound to neck, lay patient on left side in Trendelenburg with occlusive dressing over neck wound
 - b. Direct pressure to bleeding site, avoid circumferential dressings, monitor pulse for reflex bradycardia
 - 3. Maintain cervical immobilization, avoid cervical collars or other devices that obstruct your view of the neck
 - 4. Stabilize impaled object if not obstructing airway

III. Nasal injuries

- A. Review of anatomy and physiology

1. Nasal bone - between the eyes
 2. Nasal cartilage - defines shape of nose
 3. Internal structures - septum, turbinates and sinuses
 - B. Mechanism of injury
 1. Blunt - motor vehicle crashes, body-to-body contact, falls
 2. Penetrating - gun shot wounds, stabbing
 3. Foreign bodies - beans, crayons, anything a child can pick up
 - C. Pathophysiology
 1. Epistaxis - nose bleeds (may compromise airway)
 - a. Anterior bleeds - from septum, venous bleeding
 - b. Posterior bleeds - often drains down back of throat
 - c. Associated injury
 - (1) Sphenoid and/ or ethmoid bone fractures
 - (2) Basilar skull fracture
 2. Foreign bodies
 - a. Common in young children
 - b. Leave alone and transport
 - c. Attempt to remove only if airway is compromised
 - D. Assessment
 1. Airway patency
 2. Cervical spine precautions
 3. CSF drainage
 4. Associated injuries
 - E. Management
 1. Direct pressure
 2. If bleeding severe, treatment similar to hemorrhagic shock
 - a. Sit upright, leaning forward or lying on side so blood is not swallowed
 3. If CSF detected do not apply direct pressure, let drain freely
 4. Elevate head of bed in reverse Trendelenburg
- IV. Ear injuries
- A. Review of anatomy and physiology
 1. Outer ear - Pinna
 - a. Cartilage
 - b. Poor blood supply
 2. External ear canal
 - a. Considered a mucous membrane but secretes wax for protection

3. Middle ear
 - a. Separated from external canal by ear drum
 - b. Delicate structures necessary for hearing
 - B. Mechanism of injury
 1. Blunt - motor vehicle crashes, body-to-body contact, augmented force
 2. Penetrating - gun shot wound, cutting, foreign body, puncture wound
 3. Blast injuries-explosions
 4. Pressure injuries-diving
 - C. Pathophysiology
 1. Ruptured ear drum
 2. Basilar skull fracture
 3. Separation of ear cartilage
 - D. Assessment
 1. Adequate assessment of external ear canal and middle ear cannot be done in the field
 2. Airway patency and adequate ventilation a priority
 3. Maintaining adequate tissue perfusion
 4. Additional injuries
 - a. If mechanism warrants, cervical spine precautions
 - E. Management
 1. Considerations
 - a. Difficult for cartilage to heal
 - b. Infection is prime influence for failure to heal
 2. Realign ear into position and gently bandage with sufficient padding
 3. Cover draining ear with loose dressing
- V. Eye injuries
- A. Review of anatomy and physiology
 1. External parts
 - a. Bony orbit
 - b. Eyelids
 - c. Lacrimal apparatus
 2. Internal parts
 - a. Sclera
 - b. Cornea
 - c. Conjunctiva
 - d. Iris
 - e. Pupil
 - f. Lens
 - g. Retina
 - h. Optic nerve

- i. Muscle control
 - (1) Pairs
 - (2) Characteristics
 - 3. Types of vision
 - a. Central vision
 - b. Peripheral vision
- B. Mechanism of injury
 - 1. Penetrating - bullets, knives, glass, arrows, foreign bodies
 - 2. Blunt- balls, falls, vehicle crashes, motorcycles
 - 3. Burns- welding, sun, chemicals
- C. Pathophysiology
 - 1. Penetrating
 - a. Abrasions
 - b. Foreign bodies
 - (1) Superficial
 - (2) Deep
 - c. Lacerations
 - (1) Superficial
 - (2) Deep
 - 2. Blunt
 - a. Swelling
 - b. Conjunctival hemorrhage
 - c. Hyphema
 - d. Ruptured globe
 - e. Blow-out fracture of orbital rim
 - f. Retinal detachment
 - 3. Burns
 - a. Flash burns
 - b. Acid/ alkali
 - 4. Other
 - a. Lacerated eyelid
 - b. Impaled object
 - c. Avulsion
- D. Assessment
 - 1. History
 - a. When did the symptoms begin
 - b. Mechanism of injury
 - c. What did the patient first notice
 - d. Were both eyes effected?
 - e. Past history
 - (1) Visual acuity - glasses, contacts
 - (2) Diseases or conditions - glaucoma, etc.
 - f. Any medications

- 2. Physical assessment
 - a. Addressing priorities
 - (1) Maintaining open airway and assuring adequate ventilation
 - (2) Controlling bleeding and supporting cardiovascular system
 - (3) Potential for central nervous system injury
 - b. Orbital rim
 - c. Lids
 - d. Cornea
 - e. Conjunctiva
 - f. Eye movement
 - (1) Dysconjugate gaze
 - (2) Paralysis of gaze
 - g. Pupils
 - h. Visual acuity
- E. Management
 - 1. Blunt trauma treatment
 - a. Positioning
 - b. Bandaging eye(s)
 - (1) One versus both
 - (2) No pressure
 - 2. Penetrating trauma treatment
 - a. Positioning
 - b. Removal of foreign bodies versus not
 - c. Moist bandage versus dry
 - d. Stabilize impaled object
 - 3. Avulsion treatment
 - 4. Burn
 - a. Acid/ alkali
 - b. Flash burn
 - 5. Lacerated eyelid treatment

VI. Mouth injuries

- A. Introduction
 - 1. Incidence
 - 2. Morbidity and mortality
 - 3. Risk
- B. Review of anatomy/ physiology of the mouth
 - 1. Muscles
 - a. Tongue
 - b. Orbicular oris - lips
 - c. Masseter muscles - cheeks
 - 2. Nerves

- a. Hypoglossal
- b. Glossopharyngeal
- c. Trigeminal (mandibular branch)
- d. Facial
- 3. Bones
 - a. Hyoid
 - b. Palate
 - c. Mandible
 - d. Maxilla
- 4. Teeth
- 5. Salivary glands
- 6. Lymphoid tissue
- C. Mechanisms of injury
 - 1. Blunt
 - a. Motor vehicle crash
 - b. Blows to the mouth or chin
 - 2. Penetrating
 - a. Gun shot wounds
 - b. Lacerations or punctures
- D. Pathophysiology
 - 1. Lacerated tongue
 - a. Airway compromise
 - (1) Blood and tissue
 - (2) Inability to communicate
 - b. Broken or avulsed tooth
 - (1) Airway compromise
 - c. Impaled object
 - (1) Airway compromise
 - d. Lacerated mucous membranes
 - (1) Copious bleeding
 - (2) Airway compromise
 - 2. Assessment
 - a. Signs
 - (1) Copious bleeding
 - (2) Blood tinged mucous
 - b. Symptoms
 - (1) Inability to talk unless leaning forward to allow for drainage
 - 3. Management
 - a. Airway patency and adequate ventilation is the first priority
 - b. Impaled object
 - (1) If patient is able to breathe - stabilize
 - (2) Otherwise remove

- c. Collect tissue
 - (1) Tongue - manage as any other piece of tissue
 - (2) Tooth - rinse with normal saline and transport with patient

VII. Head trauma

A. Introduction

- 1. Incidence - approximately 4 million people sustain head injuries in the U.S. each year
- 2. Morbidity and mortality - approximately 450,000 require hospitalization
 - a. Most are minor injuries (GCS 13-15)
 - b. Major head injury (GCS <8) is the most common cause of death from trauma in trauma centers
 - c. Over 50% of all trauma deaths involve head injury
- 3. Risk
 - a. Highest in males 15-24 years of age
 - b. Infants 6 months to 2 years
 - c. Young school age children
 - d. The elderly

B. Review of anatomy/ physiology of head/ brain

- 1. Scalp
 - a. Hair
 - b. Subcutaneous tissue - contains major scalp veins which bleed profusely
 - c. Muscle - attached just above the eyebrows and at the base of the occiput
 - d. Galea - freely moveable sheet of connective tissue, helps deflect blows
 - e. Loose connective tissue - contains emissary veins that drain intracranially (becomes important as a route for infection)
- 2. Skull - divided into two main groups of bones - face and cranium
 - a. Cranial bones
 - (1) Composed of double layer of solid bone which surrounds a spongy middle layer gives greater strength
 - (2) Frontal, occipital, temporal, parietal, and mastoid
 - b. Middle meningeal artery
 - (1) Lies under temporal bone, if fractured can tear artery
 - (2) Source of epidural hematoma

- c. Skull floor - many ridges
- d. Foramen magnum - opening at base of skull for spinal cord
- 3. Brain - occupies 80% of intracranial space
 - a. Divisions
 - (1) Cerebrum - each lobe named after skull plates that lie immediately above
 - (a) Cortex controls
 - i) Voluntary skeletal movement - interference with will result in extremity paresthesia, weakness and/ or paralysis
 - ii) Level of awareness - part of consciousness
 - (b) Frontal lobe - personality, trauma here may result in placid reactions or seizures
 - (c) Parietal lobe - somatic sensory input, memory, emotions
 - (d) Temporal lobe - speech centers here, 85% of population has center on left, long term memory, taste and smell
 - (e) Occipital lobe - origin of optic nerve, trauma here may cause complaints of seeing "stars", blurred vision or other visual disturbances
 - (f) Hypothalamus - centers for vomiting, regulating body temperature and water
 - (2) Cerebellum - coordination of voluntary movement started by cerebral cortex
 - (3) Brain stem - connects the hemispheres of the brain, cerebellum and spinal cord responsible for vegetative functions and vital signs
 - (a) Parts - midbrain, pons and medulla oblongata
 - (b) Cranial nerves
 - i) CN III - oculomotor, origin from midbrain - controls pupil size - pressure on nerve paralyzes nerve, pupil unreactive
 - ii) CN X - vagal, origin from medulla - a bundle of nerves, primarily from parasympathetic system, that supply SA and AV node, stomach and

- GI tract - pressure on nerve stimulates bradycardia
 - iii) Reticular activating system - level of arousal and responsible for specific motor movements
 - b. Level of consciousness
 - (1) Reticular activating centers - level of arousal
 - (2) Intact cortical function - level of awareness
 - c. Meninges - protective layers that surround and enfold entire CNS
 - (1) Dura mater - outer layer, tough and fibrous; literally two layers, inner layer serves to divide and separate various brain structures, forms the tentorium that surrounds the brain stem and separates the cerebellum below from the cerebral structures above, used as a landmark to describe intracranial lesions or when swelling is involved
 - (2) Arachnoid - middle layer, web-like with venous blood vessels that reabsorb cerebrospinal fluid
 - (3) Pia mater - inner layer, directly attached to brain tissue, provides form
 - d. Cerebral spinal fluid (CSF) - clear, colorless fluid, circulates through entire brain and spinal cord
 - (1) Function - cushion and protect
 - (2) Ventricles - in center of brain, secretes CSF by filtering blood, forms blood-brain barrier
 - e. Metabolism and perfusion
 - (1) High metabolic rate
 - (2) Nutrients
 - (a) Consumes 20% of body's oxygen
 - (b) Glucose
 - (c) Thiamine
 - (d) Other nutrients
 - (e) Nutrients cannot be stored
 - (3) Blood supply
 - (a) Vertebral arteries
 - (b) Receives 15% cardiac output
 - (4) Perfusion
 - (a) Cerebral perfusion pressure (CPP)
 - (b) Mechanism called autoregulation

regulates body's blood pressure to maintain CPP

- (c) CPP = mean arterial pressure (MAP) - ICP
- (d) MAP of at least 60 mmHg required to perfuse brain
- (e) Interference with CPP - edema, bleeding, hypotension

- C. Mechanisms of injury
 - 1. Motor vehicle crashes
 - a. Most common cause of head trauma
 - b. Most common cause of subdural hematoma
 - 2. Sports
 - 3. Falls
 - a. In elderly or in presence of alcohol abuse
 - b. Associated with chronic subdural hematomas
 - 4. Penetrating trauma
 - a. Missiles (rifles, hand guns, shotguns) more common
 - b. Sharp projectiles (knives, ice picks, axes and screwdrivers) not as common
- D. General categories of injury
 - 1. Coup injuries
 - a. Directly below point of impact
 - b. More common when front of head struck because of irregularity of inner surface of frontal bones; occipital area is smooth
 - 2. Contrecoup injuries
 - a. On the pole opposite the site of impact
 - b. More common when back of head struck because of irregularity of inner surface of frontal bones
 - 3. Diffuse axonal injury (DAI)
 - a. Shearing, tearing, stretching force of nerve fibers with axonal damage
 - b. More common with vehicular occupants and pedestrians struck by vehicle
 - 4. Focal injury
 - a. An identifiable site of injury limited to a particular area or region of the brain
- E. Causes of brain injury
 - 1. Direct or primary
 - a. Caused by the impact
 - b. Mechanical disruption of cells
 - c. Vascular permeability
 - 2. Indirect - secondary or tertiary
 - a. Secondary - caused by edema, hemorrhage, infection

- and pressure inadequate perfusion (ischemia)
tissue hypoxia
- b. Tertiary - caused by apnea, hypotension, pulmonary resistance and change in ECG
- F. Head injury - broad and inclusive
 - 1. Defined - a traumatic insult to the head that may result in injury to soft tissue, bony structures and/or brain injury
 - 2. Categories - blunt (closed) trauma and open (penetrating trauma)
 - 3. Blunt head trauma
 - a. More common
 - b. Dura remains intact
 - c. Brain tissue not exposed to the environment
 - d. May result in fractures, focal brain injuries and/or diffuse axonal injuries (DAI)
 - 4. Penetrating head trauma
 - a. Less common, gun shot wound most frequent cause
 - b. Dura and cranial contents penetrated
 - c. Brain tissue exposed to the environment
 - d. Results in fractures and focal brain injury
- G. Brain injury
 - 1. Defined (by National Head Injury Foundation) - "a traumatic insult to the brain capable of producing physical, intellectual, emotional, social and vocational changes"
 - 2. Categories - focal injury, subarachnoid hemorrhage or diffuse axonal injury
 - a. Focal injury - specific, grossly observable brain lesions
 - (1) Cerebral contusion - related to severity of amount of energy transmitted
 - (2) Intracranial hemorrhage
 - (a) Penetrating
 - (b) Non-penetrating
 - (3) Epidural hemorrhage
 - b. Diffuse axonal injury (DAI) - effect of acceleration/ deceleration
 - (1) Concussion - mild and classic
 - (2) DAI - moderate and severe
- H. Pathophysiology of head/ brain injury
 - 1. Increased intracranial pressure (ICP)
 - a. Direct or indirect injury
 - (1) Edema

- (2) Bleeding
 - (3) Hypotension
 - (4) Hypercarbia
2. Mechanism
- a. As ICP approaches MAP the gradient for flow decreases, therefore cerebral blood flow is restricted
 - b. This decreases cerebral perfusion pressure (CPP)
 - c. As CPP decreases, cerebral vasodilation occurs which results in increased cerebral blood volume which leads to an increase in ICP which results in a decreased CPP which leads to further cerebral vasodilation and so on
 - d. Hypercarbia causes cerebral vasodilation which results in increased cerebral blood volume, which leads to increased ICP, etc.
 - e. Hypotension results in decreased CPP which leads to cerebral vasodilation, etc.
3. Assessment
- a. Pressure exerted downward
 - (1) Cerebral cortices and/ or reticular activating system effected
 - (a) Altered level of consciousness - amnesia of event, confusion, disorientation, lethargy or combativeness, focal deficit or weakness
 - (2) Hypothalamus - vomiting
 - (3) Brain stem
 - (a) Blood pressure elevates to maintain MAP and thus CPP
 - (b) Vagal nerve pressure - bradycardia
 - (c) Respiratory centers - irregular respirations or tachypnea
 - (d) Oculomotor nerve paralysis - unequal/ unreactive pupils
 - (e) Posturing - flexion/ extension
 - (4) Seizures - depending on location of injury
 - b. Levels of increasing ICP
 - (1) Cerebral cortex and upper brain stem involved
 - (a) BP rising and pulse rate begins slowing
 - (b) Pupils still reactive
 - (c) Cheyne-Stokes respirations
 - (d) Initially try to localize and remove painful stimuli

- i) Eventually withdraws then flexion occurs
 - (e) All effects reversible at this stage
 - (2) Middle brain stem involved
 - (a) Wide pulse pressure and bradycardia
 - (b) Pupils nonreactive or sluggish
 - (c) Central neurogenic hyperventilation (CNH)
 - (d) Extension
 - (e) Few patients function normally from this level
 - (3) Lower portion of brain stem involved/ medulla
 - (a) Pupil blown - same side as injury
 - (b) Respirations ataxic (erratic, no rhythm) or absent
 - (c) Flaccid
 - (d) Labile pulse rate, irregular often great pulse swings in rate
 - (e) QRS, S-T and T wave changes
 - (f) Decreased BP, often labile BP
 - (g) Not considered survivable
 - c. Glasgow coma scale - method to assess level of consciousness
 - (1) Three independent measurements
 - (a) Eye opening
 - (b) Verbal response
 - (c) Motor response
 - (2) Numerical score - 3 to 15
 - (3) Head injury classified according to score
 - (a) Mild - 13 to 15
 - (b) Moderate - 8 to 12
 - (c) Severe - < 8
 - d. Vital signs
 - e. Pupil size and reaction
 - f. Presence of focal deficit
 - g. History of unconsciousness or amnesia of event
4. Management
- a. Suspect cervical spine injury
 - b. Airway and ventilation - oxygenate to 95% -100% saturations
 - (1) Oxygenation does not always require hyperventilation
 - (2) Hyperventilate with signs and symptoms of increased ICP

- (a) Do not exceed rate of 30 - does not allow for adequate exhalation and retains carbon dioxide further contributing to hypercarbia
 - (3) Avoid if possible nasal intubation - increases ICP
 - c. Circulation - start IV of isotonic fluid (NS or LR) and titrate to BP
 - (1) Prevent hypotension to preserve CPP
 - (2) If hypotension present, look for internal bleeding
 - (3) Stop external bleeding
 - d. Disability - repeated assessment crucial to monitor presence of increased ICP, GCS and focal deficit
 - e. Pharmacology
 - (1) Osmotic diuretics
 - (a) Mannitol and/ or furosemide
 - (2) Paralytics/ sedation
 - (3) Avoid glucose unless hypoglycemia confirmed
 - f. Non-pharmacological treatment
 - (1) Position - head end of the backboard elevated 30 degrees
 - (2) Decrease CNS stimulation
 - g. Transport considerations
 - (1) Trauma center candidate - follow system guidelines
 - (a) Moderate to severe head injury (GCS \leq 12)
 - (2) Use of helicopter versus ground transport
 - (3) Use of lights/ sirens
 - h. Psychological support/ communication strategies
- I. Specific Injuries - diffuse axonal injury and focal injuries
 - 1. Diffuse axonal injury - shearing, stretching or tearing of nerve fibers with subsequent axonal damage
 - a. Concussion (mild DAI) - physiologic neurologic dysfunction without substantial anatomic disruption which results in transient episode of neuronal dysfunction with rapid return to normal neurologic activity
 - (1) Epidemiology - most common result of blunt trauma to the head
 - (2) Assessment - confusion, disorientation, amnesia of the event

- (3) Management - quiet, calm atmosphere, constant orientation and reassessment, intact airway with adequate tidal volume a priority
2. Moderate DAI - shearing, stretching or tearing results in minute petechial bruising of brain tissue, brain stem and reticular activating system may be involved leading to unconsciousness
 - a. Epidemiology - occurs in 20% of all severe head injuries and 45% of all cases of DAI, commonly associated with basilar skull fracture, most survive but with neurologic impairment common
 - b. Assessment - may result in immediate unconsciousness or persistent confusion, disorientation and amnesia of the event extending to amnesia of moment-to-moment events; may have focal deficit; residual cognitive (inability to concentrate), psychologic (frequent periods of anxiety, uncharacteristic mood swings) and sensorimotor deficits (sense of smell altered) may persist
 - c. Management - quiet, calm atmosphere, avoid bright lights due to photophobia, constant orientation if conscious, frequent reassessment with loss of consciousness, intact airway with adequate tidal volume a priority
3. Severe DAI - formerly called brain stem injury, involves severe mechanical disruption of many axons in both cerebral hemispheres and extending to the brainstem
 - a. Epidemiology - represents 16% of all severe head injuries and 36% of all cases of DAI
 - b. Assessment - unconsciousness for prolonged period, posturing common, other signs of increased ICP occur depending on various degrees of damage
 - c. Management
4. Focal injury
 - a. Skull fracture - the significance is in the amount of force involved
 - (1) Epidemiology - intact galea protects skull by deflecting force more common with augmented blunt injury, such as vehicular crashes or falls from a height
 - (2) Types
 - (a) Linear (80% of all skull fractures)

- i) May have fluid leak out forming a bulge
 - ii) Fluid leak may not occur for 24 hours
 - iii) If no associated injuries there is no danger
 - (b) Depressed
 - i) Bone fragments protrude into brain
 - ii) Neurologic signs and symptoms evident
 - (c) Basilar
 - i) Extension of linear fracture to floor of skull, may not be seen on X-ray/ CT
 - ii) Signs and symptoms depend on amount of damage
 - iii) Most frequently blood vessels disrupted
 - a) CSF/ blood from ear(s) or nose - target sign
 - b) Bilateral black eyes - raccoon's sign
 - c) Bruising behind ear(s) - battle's sign
 - iv) May have seizures due to irritation of blood on brain tissue
 - (d) Open skull fractures
 - i) Severe force involved, brain tissue may be exposed
 - ii) Neurologic signs and symptoms evident
- (3) Assessment - linear fractures may be missed, depressed and open skull fractures usually found on palpation of head, use balls of fingers to palpate
 - (a) Airway patency and breathing adequacy a priority
 - (b) Vomiting and inadequate respirations are common
 - (c) Assess for signs and symptoms of increased intracranial pressure
 - i) Altered LOC
 - ii) Glasgow coma scale
 - iii) Vomiting

- iv) Pupil changes
 - v) Pulse, respiration and BP changes
 - (4) Management
 - (a) Cervical spine precautions
 - (b) Assuring clear airway and adequate ventilation with good tidal volume
 - (c) Hypoxia must be prevented to prevent secondary injury to brain tissue
 - (d) Cerebral perfusion pressure can be maintained with a systolic pressure of at least 70 mm Hg
- b. Cerebral contusion - a focal brain injury in which brain tissue is bruised and damaged in a local area; may occur at both the area of direct impact (coup) and/ or on the opposite side (contrecoup) of impact
 - (1) Epidemiology
 - (a) Relatively common in blunt head injury resulting in prolonged confusion
 - (b) Most commonly found in frontal lobes
 - (c) Often associated with a serious concussion
 - (d) Patients may have multiple sites of contusion
 - (2) Assessment
 - (a) Airway patency and breathing adequacy a priority
 - (b) Alteration in level of consciousness
 - i) Confusion or unusual behavior common
 - (c) May complain of progressive headache and/ or photophobia
 - (d) May be unable to lay down memory - repetitive phrases common
 - (e) Assess for signs and symptoms of increased intracranial pressure
 - i) Altered LOC
 - ii) Glasgow coma scale
 - iii) Vomiting
 - iv) Pupil changes
 - v) Pulse, respiration and BP changes
 - (3) Management
 - (a) Cervical spine precautions
 - (b) Assuring clear airway and adequate

- ventilation with good tidal volume
 - (c) Hypoxia must be prevented to prevent secondary injury to brain tissue
 - (d) Keep warm and comfortable
 - (e) May need to repeat information
- c. Intracranial hemorrhage
- (1) Types
 - (a) Epidural
 - (b) Subdural
 - (c) Intracerebral
 - (d) Subarachnoid
 - (2) Epidemiology
 - (a) Epidural hematomas almost always result from arterial tears, usually from the middle meningeal artery; they amount to about 0.5 to 1% of head injuries
 - (b) Subdural hematomas are more common, result from rupture of bridging veins between cortex and dura; may be acute or chronic (chronic bleeds more common in the elderly and the alcoholic)
 - (c) Subarachnoid hematoma results in bloody CSF and meningeal irritation
 - (d) Intracerebral hematoma is within the brain substance; many small, deep intracerebral hemorrhages are associated with other brain injuries (especially DAI); neurologic deficits depend on the associated injuries and the region involved, the size of the hemorrhage and whether bleeding continues
 - (3) Assessment
 - (a) May be impossible to tell which type of hematoma is present
 - i) History is important, what were they doing? What happened? What is wrong now? What doesn't seem right?
 - (b) More important to recognize the presence of brain injury
 - (c) Signs/ symptoms of increasing intracranial pressure
 - i) Headache that gets increasingly severe, vomiting, lethargy, confusion, changes in

- consciousness, comatose, pupil changes, pulse slows or becomes irregular, respirations become irregular, posturing, seizures
- (d) Signs/ symptoms of neurological deficit
- (e) Early signs and symptoms of alterations in level of consciousness
- (f) Signs of brain irritation - change in personality, irritability, lethargy, confusion, repeating words or phrases, changes in consciousness, paralysis of one side of the body, seizures
- (g) GCS
- (4) Management
 - (a) Cervical spine precautions
 - (b) Maintaining airway and adequate ventilation
 - (c) Elevating head of stretcher or backboard 30⁰
 - (d) Establish IV, manage hypotension with fluid boluses, not to exceed a systolic of 90-100 mmHg in the adult male <40 (avoid shock)
 - (e) Treat increased ICP first with assuring adequate tidal volume
 - (f) Osmotic diuretics debatable for use by paramedics
- 5. Helmet issues
 - a. Purpose of helmet
 - (1) Protect head
 - (2) Protect the brain
 - (3) Cervical spine remains vulnerable
 - b. Various types
 - (1) Full face or open face (motorcycle, bicycle, roller-blade, etc.)
 - (2) Sports helmet (football, moto-cross, etc.)
 - c. Controversy regarding removal, at scene versus hospital
 - (1) Priorities
 - (a) Airway management
 - (b) Spinal immobilization
 - (2) Factors determining need for immediate removal
 - (a) Access to airway

- (b) Patient's condition
- (3) Other considerations include
 - (a) Ready access of athletic trainer in case of sports helmet (often have special equipment to remove face piece, allowing access to airway)
 - (b) Presence of other garb which could further compromise the cervical spine if only the helmet were removed (e.g. shoulder pads)
 - (c) Firm fit of helmet may provide firm support for head
- d. Cervical spine immobilization must be done whether or not a helmet is present
- e. When helmet removal occurs
 - (1) Requires sufficient help (stay to help in ED)
 - (2) Training in specific technique necessary for efficient removal
 - (3) Requires sufficient padding